
6. Trade-off Analysis

The resource planner must often compare alternative proposed actions, each of which would result in HU changes for different evaluation species. Such comparisons involve value judgments which oftentimes appear subjective and unrealistic to the public or to decisionmakers. This chapter presents a methodology which uses Relative Value Indices (RVI's) to document value judgments made during a resource planning effort. This discussion of trade-off analysis does not imply that trade-offs are desirable, but rather recognizes that most proposed actions, which would alter habitat conditions, will result in both gains and losses of different wildlife resources.

Trade-off decisions, if made, must be based on identified resource management goals, administrative policy, or both. Management goals for different evaluation species can be incorporated and evaluated through the use of RVI's. In practice, RVI's are applied as weighting values to the HU's calculated for each evaluation species. These weighting values are determined by a user-defined set of socio-economic and ecological criteria. Examples of such criteria are presented in Table 6-1. After HU's have been modified by RVI's, they no longer directly relate to habitat potential (carrying capacity) because they include value judgments.

6.1 Calculation of Relative Value Indices (RVI). The calculation of RVI values is performed in three steps: 1) defining the perceived significance of RVI criteria; 2) rating each evaluation species against each criterion; and 3) transforming the perceived significance of each criterion and each evaluation species' rating into a RVI.

The first step in RVI calculation involves the application of relative weights to each criterion to numerically define its perceived importance to the user. The suggested weighting technique is to use pairwise comparisons in which each criterion is compared to every other criterion, and a decision is made about which criterion of any pair is more important.

In the simplest application of a pairwise comparison, the options when comparing one criterion to another are to assign a value of: 1) one, which implies that the criterion is more important; 2) a zero, which implies the criterion is less important; or 3) a one-half, which implies that the criteria are of equal importance or that a decision cannot be made due to lack of information. This all or none (1 vs. 0) approach may be replaced by a proportional approach. In the latter case, the values assigned to each criterion may range from 0 to 1 with the total of each comparison equaling 1, such as 0.2 vs. 0.8 or 0.4 vs. 0.6. A dummy criterion is always included in the pairwise comparison analysis to ensure that all criteria will have some weighted value is always assigned a value of zero. When the first

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Table 6-1. Examples of Relative Value Index Criteria for Evaluation Species

Criteria	Definition	Range of value
1. Abundance or scarcity	The population within the geographic area of concern relative to the other evaluation species. If population data are not available, habitat information can be substituted.	0.1 - most abundant 1.0 - least abundant
2. Vulnerability	The probability that the populations (or habitat) of the particular evaluation species will be adversely impacted in the future without condition.	0.1 - lowest probability 1.0 - highest probability
3. Replaceability	Populations of evaluation species can be increased relatively easily through creation of additional habitat or management of existing habitat, or both.	0.1 - easily increased 1.0 - little or no opportunity to increase populations
4. Aesthetic value	A general perception of the aesthetic value attributed to the evaluation species.	0.1 - low value 1.0 - high value
5. Management efforts	The amount of effort/money expended by organizations, agencies, and institutions to preserve or enhance conditions for the evaluation species.	0.1 - little or none 1.0 - large amounts by many groups

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criterion has been compared to all other criteria, the second criterion is compared to the third, fourth, fifth, and others. These comparisons can be easily made in a simple matrix.

In Figure 6-1, the all or none approach is used to compare RVI criteria to obtain relative weights. Criterion 1 (scarcity) is compared to the criteria in each column. Comparison values are entered into the matrix cells. For example, if a decision is made that Criterion 1 (scarcity) is more important than Criterion 3 (replaceability), a value of 1 is placed in the cell where the scarcity row intersects the replaceability column. Then, a value of 0 is placed in the cell where the replaceability row intersects the scarcity column (see Appendix A, Form E, for further information on completing pairwise comparison matrices).

To obtain relative weights for each criterion, all entries for each criterion are added horizontally to obtain a total. These individual criterion totals are then added vertically to obtain a grand total (Figure 6-1). The grand total is divided into each criterion total, and the resulting value becomes the relative weight of each criterion. The relative weight represents the user determined importance of each criterion (Figure 6-1).

The second step in RVI calculation involves rating each evaluation species against each criterion. This step does not involve a partitioning of values between two choices, but rather involves an individual judgment for each evaluation species and each criterion (Figure 6-2). The user must determine what value between 0.1 and 1.0 is appropriate for each evaluation species and criterion. For example, in Figure 6-2 the white-tailed deer is rated against criterion 1, scarcity. If this evaluation species was known to be extremely scarce in the area, a value of 1.0 would be assigned; if it was moderately abundant, a value in the mid-range would be assigned; and if it was extremely abundant, a value of 0.1 would be assigned. In this example, white-tailed deer were considered moderately abundant and assigned a value of 0.5 (Figure 6-2). In practice, this process would continue until all evaluation species were rated against all criteria.

The final step in RVI calculation involves multiplication of the relative weight of each criterion determined in Step 1 by the value assigned each evaluation species in Step 2, to obtain a relative value and subsequent RVI. Figure 6-3 illustrates this process. The relative weight of each RVI criterion determined by pairwise comparison (Figure 6-1) is multiplied by the value assigned each evaluation species when compared to each criterion (Figure 6-2), and a product obtained. All products for an evaluation species are then summed to obtain a relative value. The relative value of each evaluation species is then divided by the highest relative value obtained for any evaluation species to determine each RVI. In Figure 6-3, relative

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Ranking criteria	Ranking criteria				Total	Relative weight
	(1) Scarcity	(2) Vuln.	(3) Replac.	Dummy		
(1) Scarcity	NA ^{1/}	0	1	1	2	0.33
(2) Vulnerability	1	NA	1	1	3	0.5
(3) Replaceability	0	0	NA	1	1	0.17
Dummy	0	0	0	NA	0	0.0
Grand total					6	1.0

^{1/}NA = Not applicable

Figure 6-1. Pairwise comparison matrix for example data to determine relative weight of each ranking criteria.

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Evaluation species	Criteria		
	(1) Scarcity	(2) Vul.	(3) Replac.
White-tailed deer	0.5	0.8	0.2
Ruffed grouse	0.8	0.9	0.4
Red squirrel	0.1	0.1	0.1
Red fox	0.6	0.2	0.3
Yellow-rumped warbler	1.0	1.0	1.0

Figure 6-2. Rating each evaluation species for each criterion.

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Evaluation species	Criteria			Relative value	Relative Value Index
	(1) Scarcity 0.33	(2) Vul. 0.5	(3) Replac. 0.17		
White-tailed deer Product	0.5 0.17	0.8 0.4	0.2 0.03	0.6	0.6
Ruffed grouse Product	0.8 0.26	0.9 0.45	0.4 0.07	0.78	0.78
Red squirrel Product	0.1 0.03	0.1 0.05	0.1 0.02	0.10	0.10
Red fox Product	0.6 0.20	0.2 0.1	0.3 0.05	0.35	0.35
Yellow-rumped warbler Product	1.0 0.33	1.0 0.5	1.0 0.17	1.00	1.00

Figure 6-3. Evaluation species Relative Value Indices

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values and RVI's for each evaluation species are identical because of the perceived importance of the yellow-rumped warbler (it has a relative value of 1.0); in actual practice, this may not be the case.

- 6.2 Use of RVI's. In summary, RVI can be used to adjust HU data by taking into account value judgments. After this occurs, HU's no longer are directly related to carrying capacity because value judgments have been made. However, the adjusted HU values can be used to compare base-line areas and proposed actions to determine where the greatest impact would occur. RVI can be used to adjust HU data by multiplying the net impact of a proposed action (W AAHU's) by the RVI for each evaluation species (Table 6-2). The adjusted HU values also can be used to develop alternative compensation plans (Chapter 7).

Caution is required when using RVI values in the development of compensation plans. The rules of ratio mathematics will not necessarily be upheld by this approach. Therefore a species with an RVI of 1.0 may not be precisely twice as important as a species with an RVI of 0.5. However, with some interpretation the resource manager should be able to develop a reasonably sound set of RVI scores.

Table 6-2. Aggregation of Habitat Unit data by use of Relative Value Indices.

Evaluation Species	Change in Average Annual Habitat Units	Relative Value Index	Adjusted Value (HU x RVI)
White-tailed deer	-722	0.6	-433
Ruffed grouse	-400	0.78	-312
Red squirrel	-300	0.10	-30
Red fox	-120	0.35	-42
Yellow-rumped warbler	-550	1.00	-550
Total			-1,367